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CLAIMS

1. A catheter for use in a blood vessel, comprising:
an elongate body having an axis, a lumen along said axis, a proximal opening at one
5 end, connected to the lumen and a front tip at a distal end of the body;
an elongate body section, wherein said elongate body is configured for axial motion of
at least 50 mm relative to said second elongate body section; and
an elongate hydraulic fluid column in said lumen and adapted to apply a pushing force
to said front tip in a distal direction, said force being applied at an application point, said force
10 being suitable for extending said tip at least 50 mm relative to said elongate body.
2. A catheter according to claim 1, wherein said application point is nearer said front tip
than said proximal opening.
- 15 3. A catheter according to claim 1 or claim 2, wherein said proximal opening is adapted to
be outside a human body, when the catheter is in use.
4. A catheter according to any of claims 1-3, wherein said catheter is configured so that
said liquid material does not drain into said blood vessel.
- 20 5. A catheter according to any of claims 1-4, wherein said column is adapted to be
advanced from outside a body.
6. A catheter according to any of claims 1-5, wherein said body comprises a collapsed
25 tube which extends from said tip to outside of said body and which said pushing force extends
collapsed tube.
7. A catheter according to any of claims 1-6, wherein said tip pulls along a portion of said
catheter, having a length of at least 5 times a diameter of the catheter, said length being pulled
30 by said tip when pushing force is applied to said tip.

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8. A catheter according to any of claims 1-5, wherein said body comprises a first, inner, tube and a second, outer tube, said tubes at least partially axially overlapping, wherein said pushing force extends one tube relative to the other tube.
- 5 9. A catheter according to claim 8, wherein said tip pulls at least a portion of said one tube with it when pushing force is applied to said tip.
10. A catheter according to claim 9, wherein said pulled section is too soft to be reliably pushed a distance of more than 500 mm in a human body, when the catheter is in use.
- 10 11. A catheter according to any of claims 9-10, wherein said tip pulls along a tube other than said tubes when pushing force is applied to said tip.
12. A catheter according to any of claims 9-11, wherein at least a portion of said one tube
15 is adapted to be stored outside a human body when the catheter is in use and extends out of a catheter base of said catheter.
13. A catheter according to any of claims 9-11, wherein at least a portion of said one tube is adapted to be stored outside a human body, when the catheter is in use, in a configuration
20 having a shortened axial dimension.
14. A catheter according to any of claims 8-13, wherein said inner tube extends when said force is applied.
- 25 15. A catheter according to any of claims 8-13, wherein said outer tube extends when said force is applied.
16. A catheter according to any of claims 8-13, wherein only one of said inner and said outer tubes substantially extends when said force is applied.
- 30 17. A catheter according to any of claims 8-16, wherein said fluid column is carried between said two tubes.

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18. A catheter according to any of claims 8-16, wherein said fluid column is carried within the inner tube.

19. A catheter according to any of claims 8-18, comprising a tool attached at said tip.

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20. A catheter according to claim 19, wherein said tool comprises a balloon attached at said tip.

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21. A catheter according to claim 20, comprising a separate tube with a lumen for inflating said balloon.

22. A catheter according to claim 20, wherein said balloon is attached to a metallic inflation tube.

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23. A catheter according to claim 20, wherein said inner tube serves as a lumen for inflating said balloon.

24. A catheter according to claim 23, wherein said inner tube serves as a lumen for inflating said balloon and not for said fluid column.

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25. A catheter according to claim 20, wherein said balloon is inflated via a lumen which carries said fluid column.

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26. A catheter according to claim 25, wherein said balloon is inflated using a higher pressure than used for extending said catheter.

27. A catheter according to claim 25, comprising a valve at said balloon for selectively allowing liquid flow into said balloon.

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28. A catheter according to claim 27, wherein said valve is a pressure sensitive valve.

29. A catheter according to claim 27, wherein said valve is an externally actuated valve.

30. A catheter according to claim 29, wherein said valve is a stop valve in which a block is retracted from a port to said balloon to allow fluid under pressure to enter the balloon.

31. A catheter according to claim 29, wherein said valve is a rotating stop valve having at least two configurations, and in which a block is rotated from one configuration to a second one of said configurations to selectively seal or not seal a port to said balloon.

32. A catheter according to claim 21, wherein said balloon inflation tube is adapted to be stored outside a human body, when the catheter is in use.

33. A catheter according to claim 32, wherein said tube is stored in an axially collapsed state.

34. A catheter according to any of claims 8-33, wherein said tube is adapted to extend at least 50 mm.

35. A catheter according to any of claims 8-33, wherein said one tube is adapted to extend at least 150 mm.

36. A catheter according to any of claims 8-33, wherein said one tube is adapted to extend at least 250 mm.

37. A catheter according to any of claims 8-33, wherein said one tube is adapted to extend no more than 500 mm.

38. A catheter according to any of claims 8-33, comprising at least one stop which prevents relative motion between the two tubes greater than a pre-set distance.

39. A catheter according to claim 38, wherein at least one of said at least one stop is outside of said body.

40. A catheter according to claim 38, wherein at least one of said at least one stop is not in contact with said fluid.

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41. A catheter according to claim 38, wherein said at least one stop comprises a wire extending out of said catheter and at least one movable brake section mounted on said wire.

5 42. A catheter according to claim 38, wherein said stop, when engaged, prevents liquid flow therethrough.

43. A catheter according to claim 38, wherein said stop, when engaged, does not prevent liquid flow therethrough.

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44. A catheter according to claim 38, wherein said stop, is located within 50 mm of a proximal end of the extending tube.

45. A catheter according to claim 38, wherein said stop, is located at a distance of at least
15 50 mm from a proximal end of the extending tube.

46. A catheter according to claim 38, wherein when said tube is fully extended, said stop is located at a distal end of the non-extending tube.

20 47. A catheter according to claim 38, wherein when said tube is fully extended, said stop is located at a position spaced less than 50 mm from a distal end of the non-extending tube.

48. A catheter according to claim 38, comprising a plurality of axially spaced stops.

25 49. A catheter according to claim 38, wherein said stop is an element axially shorter than 5 mm.

50. A catheter according to claim 38, wherein said stop is an element axially longer than 5 mm.

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51. A catheter according to any of claims 8-50, comprising at least one seal between said tubes.

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52. A catheter according to claim 51, wherein said at least one seal is adapted for a particular outer tube inner diameter.

53. A catheter according to claim 51, wherein said at least one seal is adapted for a range of
5 outer tube inner diameters.

54. A catheter according to claim 51, wherein said at least one seal comprises a plurality of axial spaced seals.

10 55. A catheter according to claim 51, wherein said at least one seal comprises only a single seal.

56. A catheter according to claim 51, wherein said at least one seal acts as a stop for preventing over-extension of said one tube.

15 57. A catheter according to any of claims 8-56, comprising an extension limiter which prevents steps of extension greater than a pre-set distance.

58. A catheter according to claim 57, wherein said pre-set extension step limitation is user-
20 settable.

59. A catheter according to any of claims 8-58, comprising a lock configured to selectively lock said inner tube to said outer tube and preventing motion.

25 60. A catheter according to any of claims 8-59, comprising a lock configured to selectively couple said other tube to said body.

61. A catheter according to any of claims 8-60, comprising a pressure valve configured to release pressure of said working fluid above a certain liquid pressure.

30 62. A catheter according to any of claims 8-61, comprising a controller configured to control extension of said one tube.

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63. A catheter according to claim 62, wherein said controller is adapted to extend said tube by a controlled amount.
64. A catheter according to claim 62, wherein said controller is adapted to extend said tube by setting a pressure level to be achieved in said liquid.
65. A catheter according to claim 62, wherein said controller is adapted to advance said catheter.
66. A catheter according to claim 62, wherein said controller is adapted to synchronize a locking of said catheter with inflation of a balloon portion of said catheter.
67. A catheter according to claim 62, wherein said controller is adapted to retract said tube relative to said catheter.
68. A catheter according to claim 67, wherein said controller is adapted to synchronize said retraction with advancing of said catheter.
69. A catheter according to any of claims 8-68, comprising a guiding sheath surrounding said tubes.
70. A catheter according to any of claims 8-69, comprising a guide wire, wherein said catheter is adapted to ride on said guide wire.
71. A catheter according to claim 70, wherein said catheter is configured so that said guide wire passes through said inner tube to outside a human body, when the catheter is in use.
72. A catheter according to claim 70, wherein said catheter is configured so that said guide wire passes between said inner tube and said outside tube to outside a human body, when the catheter is in use.
73. A catheter according to claim 70, wherein said catheter is configured so that said guide wire passes outside of said outside tube to outside a human body, when the catheter is in use.

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74. A catheter according to claim 70, wherein said catheter is configured so that said guide wire passes outside of a guiding sheath to outside a human body, when the catheter is in use.

5 75. A catheter according to claim 70, comprising a balloon at said tip.

76. A catheter according to claim 75, wherein said guide wire passes through an inflation lumen of said balloon.

10 77. A catheter according to claim 75, wherein said guide wire has a proximal exit from said balloon adjacent said balloon.

78. A catheter according to claim 77, wherein said balloon has a thick base from which said guide wire exits.

15 79. A catheter according to claim 77, wherein said exit is less than 20 mm from said balloon.

80. A catheter according to claim 77, wherein said guide wire passes within an inflation
20 lumen of said balloon.

81. A catheter according to claim 75, wherein said guide wire exits said catheter from said extending tube at a point distal from a most distal point of said non-extending tube.

25 82. A catheter according to claim 75, wherein said guide wire exits said catheter from said extending tube at a point proximal to a most distal point of said non-extending tube.

83. A catheter according to claim 75, wherein said guide wire passes through a seal
30 between the two tubes.

84. A catheter according to claim 75, wherein said guide wire passes a through a liquid path of said column in said catheter.

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85. A catheter according to claim 75, wherein said guide wire passes only outside of a liquid path of said column in said catheter.

86. A catheter according to any of claims 8-85, wherein said inner tube comprises a standard balloon catheter, not manufactured for fluid control and wherein said liquid is carried between said outer tube and said standard balloon catheter.

87. A catheter according to any of claims 8-85, wherein said inner tube comprises a standard balloon catheter having an adjustable seal mounted thereon, and wherein said liquid is carried between said outer tube and said standard balloon catheter.

88. A catheter according to claim 87, wherein said outer tube is a guiding catheter.

89. A catheter according to any of claims 8-88, wherein said outer tube has an outer diameter of less than 3 mm.

90. A catheter according to any of claims 8-88, wherein said outer tube has an outer diameter of less than 2 mm.

91. A catheter according to any of claims 8-88, wherein said outer tube has an outer diameter of less than 1 mm.

92. A catheter according to any of claims 8-91, wherein said inner tube has an outer diameter of less than 1.5 mm.

93. A catheter according to any of claims 8-91, wherein said inner tube has an outer diameter of less than 0.5 mm.

94. A catheter according to any of claims 1-93, wherein said application point is less than 500 mm from a most distal point of said catheter.

95. A catheter according to any of claims 1-93, wherein said application point is less than 350 mm from a most distal point of said catheter.

96. A catheter according to any of claims 1-93, wherein said application point is less than 70 mm from a most distal point of said catheter.
- 5 97. A catheter according to any of claims 1-93, comprising an offset element between said application point and said tip, which application point conveys said force from said column towards said tip.
98. A catheter according to any of claims 1-97, comprising a push wire adapted to apply a
10 second force to said tip.
99. A catheter according to claim 98, wherein said push wire applies said second force at a substantially same axial position as said application point.
- 15 100. A catheter according to claim 98, comprising a controller configured to allow a short advance of said wire, suitable for passing a narrowing in a blood vessel.
101. A catheter according to any of claims 1-100, comprising a base hub adapted to remain outside a human body, when the catheter is in use.
- 20 102. A catheter according to claim 101, wherein said base hub has only a single port for liquid pressure.
103. A catheter according to claim 101, wherein said base hub has a plurality of ports for
25 liquid pressure.
104. A catheter according to claim 103, wherein at least one of said ports has a cover adapted to remain closed when fluid inside said port is at 5 atmospheres of pressure or more.
- 30 105. A catheter according to claim 101, wherein said base hub comprises a pressure release valve.

106. A catheter according to claim 101, wherein said base hub comprises a port for a guide wire.

107. A catheter according to claim 101, wherein said base hub comprises a port for a
5 pushing wire.

108. A catheter according to claim 101, wherein said base hub comprises a port for a valve control wire.

109. A catheter according to claim 101, wherein said base hub comprises a port for an
10 extension restricting wire.

110. A catheter according to claim 109, wherein said port is configured to lock said wire when said base is pressurized above a pre-set pressure value.

111. A catheter according to claim 101, wherein said base hub comprises a selector
15 configured for selecting which of a plurality of lumens of the catheter fluid pressure will be coupled to.

112. A catheter according to claim 101, wherein said base hub comprises a closable opening
20 suitable for selectable user access to a lumen of the catheter through the door.

113. A catheter according to claim 112, wherein said opening is adapted to be quickly
opened by hand.

114. A catheter according to claim 101, wherein said base hub includes a catheter storage
25 section having a length, wherein said length is less than 80% of a length of a catheter section stored therein.

115. An extendible catheter comprising:
30 a base section adapted to remain outside a human body, when the catheter is in use;
an elongate body having a lumen and a distal tip and including a collapsed section stored in said base section; and

a liquid column adapted to apply force to said body adjacent said tip.

116. A catheter according to claim 115, wherein said collapsed section is stored in a folded configuration

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117. A catheter according to claim 115, wherein said collapsed section is stored in an axially pleated configuration.

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118. A catheter according to claim 115, wherein said collapsed section is stored in an coiled configuration

119. A catheter according to claim 115, wherein said collapsed section is stored in an axially folded configuration such that part of said section is inside-out.

15 120. A catheter according to claim 115, comprising an outer tube out of which said body exits in an uncollapsed state.

121. A catheter according to claim 115, comprising a second collapsed tube inside of said collapsed section.

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122. A catheter according to claim 121, wherein said second collapsed tube is a balloon inflation tube.

25 123. A catheter according to claim 115, comprising a feeding nozzle for uncollapsing said collapsed section.

124. A catheter with a mechanically activated fluid valve, comprising:
an elongate body having a lumen, said lumen defining a fluid path;
a tool activated by said fluid and situated at a distal section of said elongate body;
30 a fluid valve at said distal section adapted to selectively convey fluid to said tool; and
a mechanical actuator coupled to said valve and extending outside of said body to control said valve.

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125. A catheter according to claim 124, wherein said tool comprises a fluid-inflated balloon.

126. A catheter according to claim 124, wherein said catheter is adapted to have a distal section thereof extended distally by said fluid.

127. A catheter according to claim 124, wherein said actuator rotates said valve.

128. A catheter according to claim 124, wherein said actuator retracts a blocking section of said valve.

129. A catheter according to claim 128, wherein said actuator retracts a blocking section of said valve such that in a maximally retracted position the blocking section allows for passage of fluid from said lumen to said tool.

130. A method of deploying a catheter-carried tool, comprising:
inserting an extendible catheter into a blood vessel of a body; and
extending a distal section of the catheter to reach a target area, by at least a distance of 50 mm.

131. A method according to claim 130, comprising activating said tool at a distal end of said extended section.

132. A method according to claim 130, wherein said extending comprises extending by providing fluid pressure into said catheter.

133. A method according to claim 130, wherein said tool comprises a balloon.

134. A method according to claim 130, wherein inserting comprises inserting along a guide wire.

135. A method according to claim 130, wherein inserting comprises inserting through a guiding catheter/sheath.

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136. A method according to claim 130, comprising advancing said catheter after said extending.

137. A method of testing a catheter, comprising:

- 5 attaching the catheter to a source of hydraulic pressure; and
 increasing said pressure to extend a distal section of the catheter by at least 50 mm.

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